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54 System for controlling the transmission torque of a four-wheel drive vehicle.

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Description

The present invention relates to a system for a four-wheel drive vehicle for automatically controlling the transmission torque to the rear-wheels of a four-wheel drive vehicle.

During the driving of the four-wheel drive vehicle, tyre scraping occurs because of slight differences in effective wheel radii resulting from inevitable differences in tyre inflation, tread wear or variation in loading. In addition, when the vehicle negotiates corners, braking phenomenon called "tight corner braking" may occur during sharp cornering. This is caused by the front wheels running through an arc of greater radius than that of the rear wheels and therefore tending to rotate faster than the rear wheels. This will result in increase of tyre wear and fuel consumption and decrease of driveability.

In order to eliminate such disadvantages, a four-wheel drive vehicle provided with a friction clutch system having a variable transmission torque has been proposed. Generally the transmission torque is controlled in dependency on the steering angle, allowing slip to occur in the friction clutch to prevent the tight corner braking.

An object of the present invention is to provide a system for controlling transmission torque to the rear-wheels so that the transmission torque can be controlled in dependency on driving conditions other than steering angle, such as the slipping of wheels.

According to the present invention, there is provided a system for controlling a transmission torque of a four-wheel drive vehicle powered by an engine, which comprises a transmission for transmitting a power of the engine to the front wheels; a friction clutch for transmitting power to the rear wheels; and clutch operating means for engaging and disengaging the friction clutch. The invention is characterised in that the clutch operating means comprise selecting means for providing optionally partial engagement of the clutch, and engagement greater than said partial engagement, or disengagement of the clutch; and in that the control system further comprises slip detecting means for detecting slipping of the wheels; load detecting means for detecting the load on the engine; and control means responsive to signals from the slip detecting means and the load detecting means for operating the selecting means so as to engage the clutch at the greater engagement at heavy load and at slipping of the wheels.

The present invention is illustrated by the following description of an example of a control system in accordance therewith, reference being made to the accompanying drawings, in which

Figure 1 is a schematic view showing a transmission system used in conjunction with the control system;

Figure 2 is a schematic illustration showing the control system; and

Figure 3 shows an electric circuit employed in the control system.

Referring to Figure 1, 1 is a crankshaft of an internal combustion engine (not shown) mounted on a front portion of a vehicle. The crankshaft 1 of the engine is operatively connected with a torque converter 2 of an automatic transmission A.

The automatic transmission A comprises the torque converter 2, an automatic transmission device 4, and a final reduction device 14 for the front wheel drive.

The torque converter 2 comprises a pump impeller 2a and a turbine 2b. The pump impeller 2a is in direct connection with the engine crankshaft 1 through a drive plate 2c. The turbine 2b has a turbine shaft 3 which extends from the turbine 2b to the automatic transmission device 4.

The automatic transmission device A comprises a planetary gear 5, clutches 6 and 7 for selectively transmitting the output of the turbine shaft 3 to the planetary gear 5, a one-way clutch 8, a brake 9 and brake band 10 for selectively locking elements of the planetary gear 5.

The output of the automatic transmission device is transmitted to an output shaft 11 on which a drive gear 12 is securely mounted and which in turn engages with a driven gear 13. The driven gear 13 is secured on a shaft 16 which is integral with a drive pinion 17. The drive pinion 17 engages with a crown gear 15 of the final reduction device 14 for the front wheels. The shaft 16 is connected to a transfer drive shaft 18 which extends rearwardly and is connected to a first transfer gear 20 of a transfer device 19. The first transfer gear 20 is engaged with a second transfer gear 21, which is rotatably mounted on a rear drive shaft 23. A fluid pressure controlled friction clutch 22 of the multiple-disc type is mounted on the rear drive shaft 23 for engaging the gear 21 with the shaft 23. The rear drive shaft 23 is further operatively connected to a final reduction device 25 for rear wheels through a propeller shaft 24.

Referring now to Figure 2, the fluid pressure controlled friction clutch 22 comprises a cylindrical boss 26 secured to the second transfer gear 21 and a cylindrical shell 28 secured to the rear drive shaft 23. A plurality of discs 27 and 29 are alternately arranged and are respectively secured to the boss 26 and to the shell 28 by means of spline engagement. An annular pressure plate 30 is slidably mounted in the shell 28 and has an annular projection 30a and an annular groove 30b. An annular spring plate 31 is disposed between the groove 30b and a shoulder 28a of the shell 28 to urge the pressure plate towards the discs 27 and 28 and to press those discs into engagement in order to establish partial engagement of the clutch.

Piston chambers 34 and 36 are formed in the boss 26 and shell 28 respectively, and small diameter piston 33 and a large diameter piston 35 are slidably mounted in the piston chambers 34 and 36, respectively. The small diameter piston 33 has an annular abutment 33a and the large diameter piston 35 has an annular abutment 35a, which are arranged to engage with opposite sides of the pressure plate 30. An annular return spring

plate 32 is disposed between the small diameter piston 33 and the inside cylindrical wall portion 28b of the shell 28 to urge the small diameter piston in the disengaging direction.

The piston chamber 34 is communicated with a solenoid valve 39 by a conduit 37 a part of which is provided in the rear drive shaft 23. The piston chamber 36 is similarly communicated with a solenoid valve 40 by means of a conduit 41. Inlet ports 50 and 52 of the two valves communicate with an oil pump 38 and drain ports 51 and 53 communicate with a tank 48.

A front wheel speed sensor 42 and a rear wheel speed sensor 43 detect respective speeds for applying signals to a control circuit 46 in dependency on the speeds, respectively. An engine load sensor 45, such as a vacuum sensor for detecting vacuum in the induction passage of the engine, detects the load on the engine and applies an output to the control circuit 46 in dependency on the load. Further, a manual switch 44 is electrically connected to the control circuit 46 for selectively operating the solenoid valve 39.

The control circuit 46 is arranged to produce output signals to energize a solenoid 39a of the solenoid valve 39 on the closing of the manual switch 44, and to energize both solenoids 39a and 40a by a heavy load signal from the load sensor 45. Further, the control circuit 46 computes signals from the speed sensor 42 and 43 to obtain slip rates of the front and rear wheels and produces an output to energize the solenoid 40a when the slip rate exceeds a predetermined value.

In operation, during a driving condition at a low load while switch 44 is open, solenoid 39a and 40a are de-energized, so that oil chambers 34 and 36 are communicated with tank 48 through the drain ports 51 and 53. Thus, the small diameter piston 33 and large diameter piston 35 do not act on the pressure plate 30. The pressure plate 30 is engaged with the clutch by the spring force of the spring plate 31 thereby to establish partial engagement of the clutch, with clutch discs 27 and 29 engaging at a slight force with each other. Thus, the vehicle is driven by its four wheels during ordinary driving conditions.

When the vehicle turns a corner, clutch 22 slips to allow the rear wheels to rotate slower than the front wheels. When the load sensor 45 produces a first heavy load signal at a heavy load, solenoids 39 and 40 are energized to shift the respective plungers of valves 39 and 40 and to connect the pump 38 with conduits 37 and 41, respectively. Thus, pressure oil is applied to oil chambers 34 and 36, so that the pressure plate 30 is pressed against the clutch by a force corresponding to the force of the spring plate 31 plus the difference between the forces applied by large diameter piston 35 and a small diameter piston 33. Thus, the clutch 22 is engaged with a larger proportion of the clutch discs than during partial engagement by means only of the spring plate 31. Therefore, a suitable transmission torque meeting the heavier load is provided for the rear

wheels. When the engine load increases further, the load sensor 45 produces a second heavy load signal which causes the solenoid 39a to be de-energized. Then the small diameter piston 33 is returned to the retracted position by spring plate 32 and pressure plate 30 is engaged with the clutch with the larger force provided by the spring plate 31 and the large diameter piston 35. Therefore, the clutch engages with the entire part of discs to provide the maximum transmission torque for producing sufficient four-wheel driving power. Since the transmission torque changes in dependency on the engine load, the vehicle can be driven by an appropriate torque to provide a desirable driveability.

When at least either of the front or rear wheels slip and the slip rate computed by the control circuit 46 exceeds a predetermined value, the solenoid 40a is energized. Thus, the clutch 22 is wholly engaged to establish complete four-wheel drive thereby ensuring a stable driving.

When the manual switch 44 is closed, the solenoid 39a is excited to pass the pressure oil to the oil chamber 34. Thus, the small diameter piston 33 is moved to the right to disengage the pressure plate 30 from the clutch discs. Accordingly, clutch 22 is disengaged to provide front-wheel drive only. Under front-wheel drive, when the control circuit 46 produces a slip signal dependent on the signals from the speed sensors 42 and 43, solenoid 40a is energized and solenoid 39a is de-energized to establish the four-wheel drive.

Figure 3 shows an example of the control circuit 46. The control circuit comprises a pair of frequency-to-voltage converters 55 and 56 electrical connected to the speed sensors 42 and 43 for converting output pulses of the speed sensors to voltages, respectively. The outputs of the converters 42 and 43 are applied to a differential amplifier 57 which detects the difference between the inputs and hence slippage of one of the front and rear wheels. The output of the differential amplifier 57 is applied to a comparator 58 which produces an output when the output of the differential amplifier exceeds a predetermined level, that is when significant slippage occurs. The output of the comparator 58 is applied to a logic circuit 60 through a delay circuit 61. The logic circuit 61 operates in dependency on the input signals from delay circuit 61, manual switch 44 and load sensor 45 to turn on transistors 62 and 63 to energize solenoids 39a and 40a. The load sensor 45 has a switch 64 which is closed when the load is light.

Claims

1. A control system for controlling a transmission torque of a four-wheel drive vehicle powered by an engine comprising a transmission (2, A, 14) for operatively transmitting power from the engine to the front wheels; a friction clutch (22) for transmitting the power to the rear wheels; and clutch operating means (30, 33, 35) for engaging and disengaging the friction clutch, characterised

in that the clutch operating means comprise selecting means (39, 40) for providing optionally partial engagement of the clutch, an engagement greater than said partial engagement, or disengagement of the clutch; and in that the control system further comprises slip detecting means (42, 43) for detecting slipping of the wheels; load detecting means (45) for detecting the load on the engine; and control means (46) responsive to signals from the slip detecting means and the load detecting means for operating the selecting means so as to engage the clutch at the greater engagement at heavy load and at slipping of the wheels.

2. A control system according to claim 1, having a manual switch (44) for operating the selecting means to cause clutch disengagement.

3. A clutch system according to claim 1, wherein the friction clutch is a fluid pressure controlled friction clutch of the multiple-disc type.

4. A control system according to claim 3, wherein the control means comprises a pressure oil supply circuit including solenoid valves (39, 40) for operating the clutch and an electric circuit (46) for operating the solenoid valves.

Patentansprüche

1. Einrichtung zur Regelung des Antriebsdrehmoments eines allradgetriebenen Kraftfahrzeugs mit einem Motor, mit einer Transmission (2, A, 14) zur wirksamen Kraftübertragung vom Motor auf die Vorderräder, mit einer Reibungskupplung (22) für die Kraftübertragung auf die Hinterräder, und mit einer Kupplungsbetätigungseinrichtung (30, 33, 35) zum Einkuppeln und Trennen der Reibungskupplung, dadurch gekennzeichnet, daß die Kupplungsbetätigungseinrichtung eine Auswahl-einrichtung (39, 40) aufweist, die wahlweise eine Teileinkupplung, eine Einkupplung stärker als die Teileinkupplung oder ein Trennen der Kupplung ermöglicht; und daß die Regelungseinrichtung eine Schlupferfassungseinrichtung (42, 43) zum Erfassen des Schlupfes der Räder, eine Belastungserfassungseinrichtung (45) zum Erfassen der Motorbelastung und eine Regelvorrichtung (46) aufweist, die in Abhängigkeit von den Signalen der Schlupferfassungseinrichtung und der Belastungserfassungseinrichtung die Auswahl-einrichtung so betätigt, daß bei schwerer Belastung und bei Schlupf der Räder die Kupplung die stärkere Einkupplung erfolgt.

2. Regelungseinrichtung nach Anspruch 1, mit einem Handschalter (44) für die Betätigung der Auswahl-einrichtung zur Trennung der Kupplung.

3. Regelungseinrichtung nach Anspruch 1, in der die Reibungskupplung eine flüssigkeitsdruck-regelte Reibungskupplung vom Mehrscheiben-typ ist.

4. Regelungseinrichtung nach Anspruch 3, in der die Regelvorrichtung einen Öldruckversor-gungskreis mit Magnetventilen (39, 40) für die Be-tätigung der Kupplung und einen elektrischen Kreis (46) zur Betätigung der Magnetventile auf-weist.

Revendications

1. Système de commande du couple de trans-mission d'un véhicule à quatre roues motrices propulsé par un moteur qui comprend une trans-mission (2, A, 14) pour transmettre effectivement l'énergie du moteur à roues avant, un accouple-ment à friction (22) pour transmettre l'énergie aux roues arrière et des moyens d'actionnement (30, 33, 35) pour embrayer et débrayer l'accouplement à friction, caractérisé en ce que les moyens pour actionner l'accouplement comprennent des moyens de sélection (39, 40) pour produire, le cas échéant, une application partielle de l'accouplement, une application plus grande que cette application partielle ou un débrayage de l'accouplement et en ce que le système de com-mande comprend, en outre, des moyens (42, 43) pour détecter le patinage ou le glissement des roues, des moyens pour détecter la charge imposée au moteur et des moyens de commande (46) qui, en réponse aux signaux des moyens détec-tant le patinage et des moyens détectant la charge, actionnent les moyens de sélection, de façon à embrayer l'accouplement plus fortement lorsque la charge est lourde et lorsque les roues patinent.

2. Système de commande selon la revendica-tion 1, caractérisé en ce qu'il comprend un commutateur manuel (44) pour actionner les moyens de sélection, afin de provoquer le dé-brayage de l'accouplement.

3. Système de commande selon la revendica-tion 1, caractérisé en ce que l'accouplement à fric-tion est un accouplement commandé par un fluide sous pression du type à disques multiples.

4. Système de commande selon la revendica-tion 3, caractérisé en ce que les moyens de com-mande comprennent un circuit d'alimenta-tion d'huile sous pression incluant des valves électromagnétiques (39, 40) pour actionner l'accouplement et un circuit électrique (46) pour actionner les valves électromagnétiques.

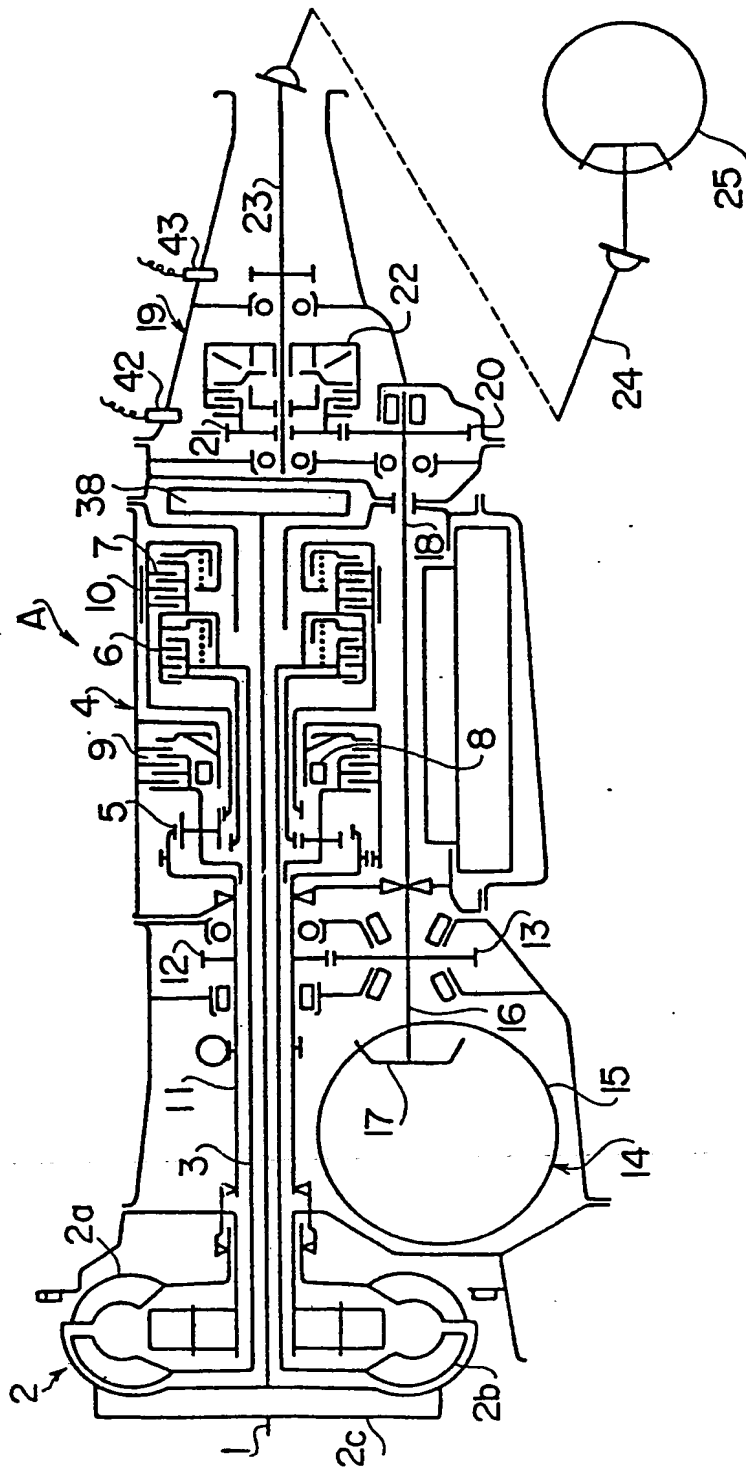


FIG. 1

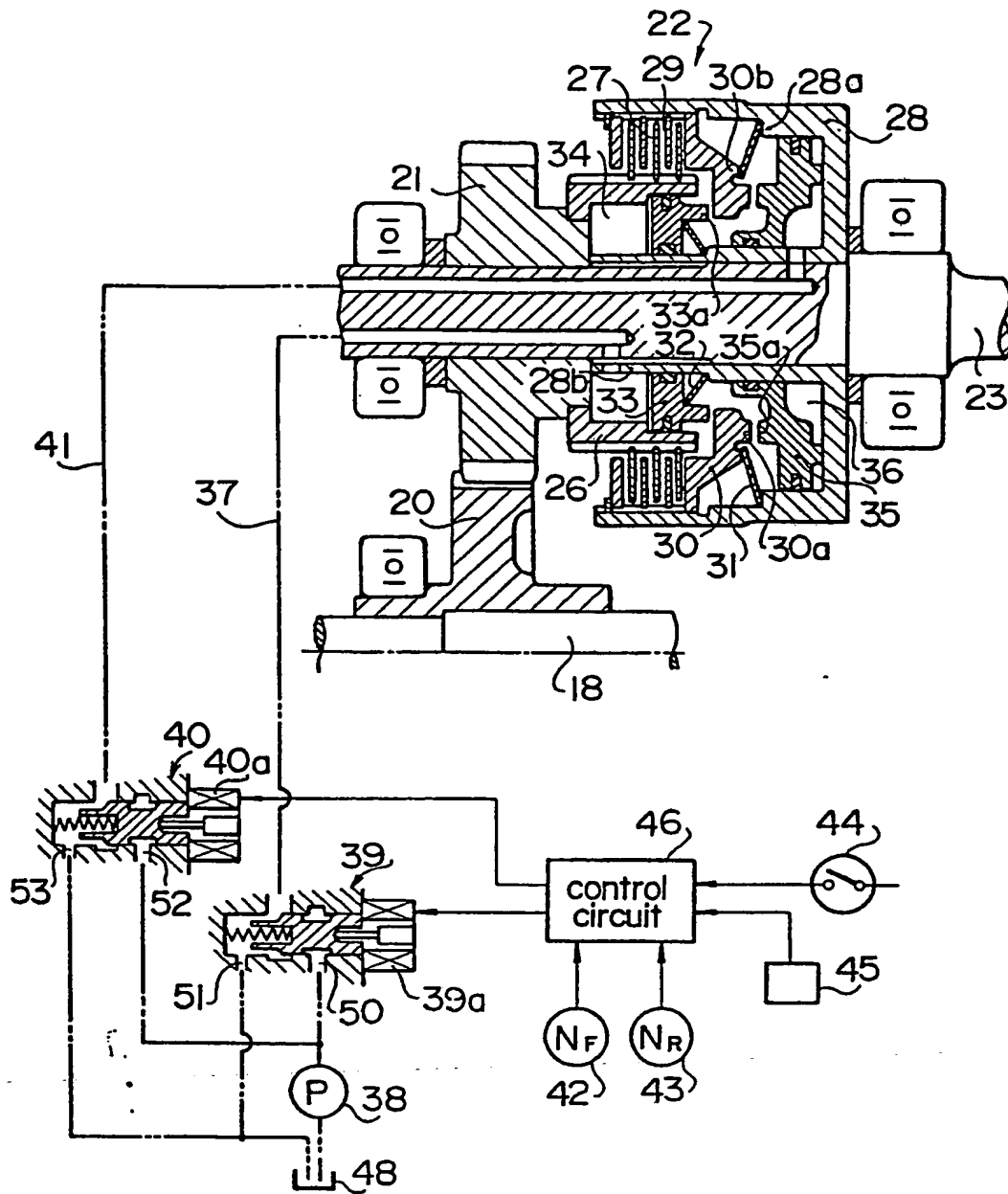
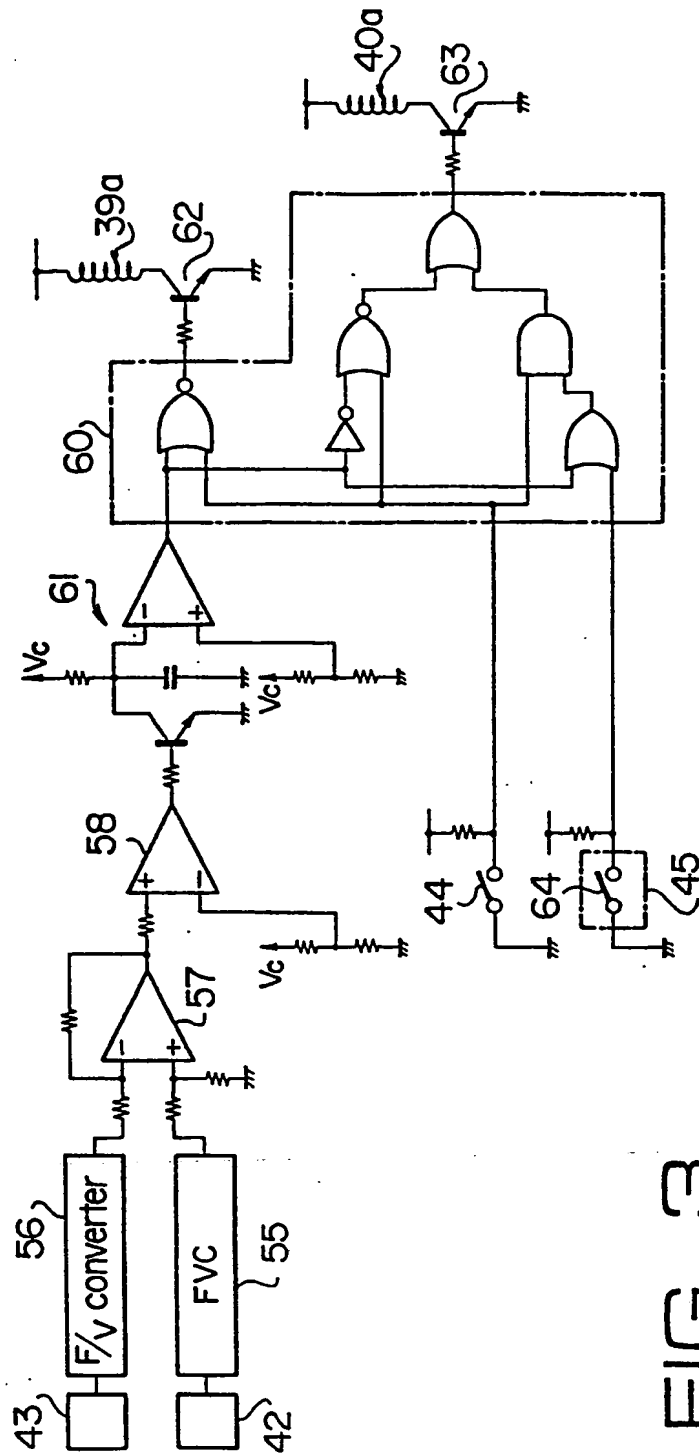


FIG. 2



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